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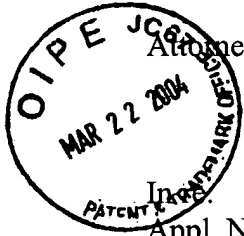
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Attorney's Docket No. 43197.271470

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: Adams et al.
Appl. No.: 10/717,173
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For: STENCIL MASTER

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P.O. Box 1450
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SUBMITTAL OF PRIORITY DOCUMENT

To complete the requirements of 35 U.S.C. § 119, enclosed is a certified copy of Great Britain priority Application No. 0226910.8, filed November 18, 2002.

Respectfully submitted,

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| 5. Name of your agent (if you have one) | Gill Jennings & Every | | |
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STENCIL MASTERField of the Invention

5 The present invention relates to stencils and stencil masters for use in digital duplicating printing processes, and to a method for making stencils and stencil masters for such use.

Background to the Invention

10 Existing stencils for use in digital duplicators comprise a heat-sensitive film laminated to tissue paper. The tissue paper may be formed from natural fibres such as hemp, synthetic fibres, synthetic microfibres or blends thereof. The main purposes of the tissue component are (i) to provide stiffness and strength to the film during the
15 imaging and printing processes, and (ii) to control the flow of ink through the stencil during the printing process. Whilst such stencils can provide results which are technically acceptable, the contribution of the cost of the tissue paper to the cost of the stencil can adversely
20 effect the economies of stencil printing in relation to other processes. This is a particular problem when tissues comprising a large proportion of synthetic microfibres are required for printing high resolution images. Even at low resolution, printing by digital duplicator becomes
25 uncompetitive against other print processes such as xerography when only a few prints are required. By achieving a lower cost construction for digital stencil masters printing by digital duplicator will become economically viable for lower numbers of copies than
30 hitherto possible.

It has, therefore, been proposed that the tissue component of digital stencils should be replaced by a porous coating. One method of achieving this is described in GB 2306689, GB 2336916 and GB 2350691 and is based on
35 the precipitation of a resin from a coating solution as a consequence of the change in solvent composition during the

drying process. However this method has a number of disadvantages:

(1) A very precise blend of solvents is required. Manufacturing batch variations in the polymer resin, eg. in
5 molecular weight or monomer composition, cause variations in solubility. As a consequence the coating formulation has to be adjusted for each manufacturing batch of resin.

(2) When water is one of the solvent components, variations in ambient water vapour levels causes variations
10 in the pore forming process.

(3) Because solubilities are temperature dependent, the temperatures of the coating mix and drying process have to be precisely controlled.

(4) The resulting porous medium is not particularly
15 cohesive and the incorporation of whisker mineral fillers is advocated as a means of reinforcing the structure. However, these minerals can act to limit the porosity of the coating to an extent that the printing properties of the resultant stencil are impaired.

20 5) The method relies on the use of volatile organic solvents which is undesirable because of their adverse environmental impact. In many countries use of volatile organic compounds in manufacturing processes is subject to legislation requiring the installation of expensive
25 treatment facilities to recover or destroy effluent solvent vapour.

A second method which has been described in GB 2332868 and GB 2345912 is based on the use of coatings which are emulsions of water in a volatile organic solvent containing
30 a dissolved resin. Through the achievement of a sequential drying process, where the volatile organic solvent is largely evaporated before the water, porous coatings are created. This method too has been found to exhibit a number of disadvantages:

35 (1) In practice it is difficult to select resins which achieve both a satisfactory degree of pore formation and also acceptable properties such as stiffness and

coating adhesion in the resultant stencil.

(2) The sequential drying process requires expensive and technically demanding solutions in the design of the continuous web-coating machine. The drying section needs to be long and it is difficult to achieve satisfactory tension control for ultra thin films with relatively heavy coatings which are being processed under these conditions.

(3) As in the other coating process, this approach also requires use of volatile organic solvents.

It is an objective of the present invention to provide a method of manufacture of thermosensitive stencils which avoids the use of adhesive and paper, and which also avoids the afore-mentioned shortcomings. A further objective is to produce a stencil master having excellent properties in respect of handling, imaging and printing.

Summary of the Invention

According to a first aspect of the present invention, a heat-sensitive stencil master comprises a heat-sensitive polymeric film having a thickness of less than 10 μm and, coated thereon, a solid resinous foam comprising a foaming agent.

According to a second aspect of the present invention, a heat-sensitive stencil for use in a digital duplicating printing process comprises a stencil master of the type described above which has been thermally imaged to produce voids in the heat-sensitive polymeric film.

According to a third aspect of the claimed invention, a method for manufacturing a stencil master comprises coating on to a heat-sensitive polymeric film having a thickness of less than 10 μm , a liquid foam comprising a resin, or polymer, dispersed or dissolved in a volatile liquid, and a foaming agent, and drying the liquid foam to form a solid foam coating on the heat-sensitive film.

Detailed Description of the Invention

The film component of the stencil master is a heat-sensitive polymeric film of the type used in conventional thermally-imaged stencils which are film-tissue laminates.

In particular, the film must be capable of perforation by a thermal printing head of the type used in a digital duplicator printing machine.

5 The heat-sensitive film is less than 10 μm in thickness, and typically less than 5 μm , for instance less than or equal to 3 μm , in thickness.

The solid foam coating formed on the film is resinous, or polymeric, in nature. The resin may be any polymer which is capable of being incorporated into a volatile liquid
10 which as a liquid foam can be dried to yield a solid foam. Typically, the resin may either be thermoplastic or cross-linked. Suitable resins include but are not restricted to polymers, co-polymers or more complex polymeric permutations of ethylene, propylene, butene, butadiene,
15 styrene, acrylonitrile, vinyl acetate, vinyl alcohol, vinyl acetal, vinyl butyral, vinyl formal, vinyl chloride, vinylidene chloride, vinyl fluoride, vinylidene fluoride, maleic anhydride, acrylic acid, methacrylic acid, acrylic acid esters, methacrylic acid esters, vinyl methyl ether,
20 vinyl pyrrolidone. Also suitable are resins which fall within the categories: polyester, polyamide, polyurethane, cellulose ether, cellulose ester, nitrocellulose, polyketone, rubber, alkyd, polyphenylene oxide, polycarbonate, epoxy and silicone.

25 Typically, for coating onto the heat-sensitive film, the resin will be dissolved in a volatile liquid or present as a resin emulsion or non-aqueous dispersion in a volatile liquid, to form a coating liquid which will form the basis for a liquid foam. In the context of the present
30 Application, a volatile liquid is one which will evaporate from the liquid foam while on the coating machine at a temperature less than the shrink temperature of the heat-sensitive film. Typically, the volatile liquid will have a normal boiling point of at least 40°C and at most 120°C,
35 although liquids with higher boiling points may also prove useful provided the drying conditions are selected so as to avoid substantial shrinkage of the heat-sensitive film.

Non-aqueous liquids may be used, but the preferred liquid for use in the present invention is water, for processing and environmental reasons.

5 The resin may be cross-linked before, during or after the coating operation, for instance by chemical reaction or by irradiation. In one specific embodiment, the resin component of the liquid foam is a water-based emulsion which is capable of being cross-linked by ultraviolet or electron beam irradiation. Such emulsions must be capable
10 of forming a solid foam on evaporation of the water component prior to irradiation. Good results have been achieved by electron beam curing of emulsions based on acrylate derivatives of polyol polyurethanes. Using a dose in the range 3-5 MRad and acceleration voltages in the
15 range 125-200 Volts significant increases have been achieved in both the stiffness and tensile strength of the solid foam coatings.

Typically, the amount of resin solids included in the coating liquid is in the range 5-50% by weight. Lower
20 amounts of resin may be used, but will require more time/energy to dry the coating.

The foam coating further comprises a foaming agent, or foam stabilizer; the two terms are often interchangeable in the art. Suitable foaming agents include surfactants. In
25 the case of water-based systems, it is preferred to use a foaming agent having an HLB value of greater than 6, ie. one which favours the formation of oil-in-water emulsions.

Specific examples of suitable foaming agents include but are not limited to anionic materials such as alkyl
30 sulphates, alkylaryl sulphates, alkylarylether carboxylates, alkylarylether sulphates, olefin sulphonates, paraffin sulphonates, phosphate esters, sarcosinates, sulphosuccinates, sulphosuccinamates, taurates, isethionates; cationic materials such as amides,
35 amidoamines, imidazolines, quaternaries; nonionic materials such as alcohol ethoxylates, alkylphenol ethoxylates, amide ethoxylates, amine ethoxylates, alkylolamides, amine

oxides; and amphoteric materials such as betaines, glycinates, imidazolines, propionates. There is no limit in the selection of the foaming agent, other than it should not impair other characteristics of the liquid foam eg. stability of the resin emulsion, or properties of the resultant solid foam, eg. foam stiffness. Favoured materials are salts of long chain fatty acids, such as ammonium stearate.

Typically, the amount of foaming agent included in the coating liquid is in the range 0.5-25% by weight, preferably 1-5% by weight. Higher amounts of foaming agent may be used, but have little impact on liquid foam structure.

Fibrous materials may be advantageously incorporated to improve the stiffness of the solid foam. These include but are not restricted to glass, carbon and polymer fibres such as polyester and polyvinyl alcohol. Choice of fibre thickness, or diameter, is based on a consideration of the size of pixel voids. The fibre thickness should be sufficiently low not to impede ink flow through these voids. However, it is desirable to have as great a fibre thickness as possible in order to maximise coating stiffness. Suitable fibres will typically have a diameter of greater than 1 μm and less than 10 μm . The fibres will typically have a length in the range 1 to 14 mm, preferably 1 to 5 mm.

If fibrous material is to be included in the stencil master, the higher the amount of fibrous material the higher the tensile strength and stiffness of the stencil master. The weight ratio of fibrous material:resin solids (in the dry solid foam) may be as high as 1:1, or even higher than this. However, typically, the weight ratio of fibrous material:resin solids will be in the range 1:5 to 1:30, preferably 1:5 to 1:15.

We have found that the incorporation of carbon fibres in particular has enabled significant improvements in the tensile strength and stiffness of the solid foam.

Pigments and fillers may be incorporated in the foam coating, including inorganic materials such as talc, mica, clay, silica, micronised silica gel, calcium carbonate, aluminum silicate, barytes, titanium dioxide, zinc oxide, carbon black and organic materials such as waxes and other resin particles, starch and other cellulose based derivatives.

Other functional additives may be incorporated in the foam coating, including antistatic agents, release agents and colorants. Suitable antistatic agents include materials having a surface electrical resistance of up to $10^{12} \Omega$ per square. Other additives may be incorporated to improve the coating quality of the liquid foam, such as wetting agents, dispersing agents and viscosity modifiers. Useful viscosity modifiers include sodium carboxymethylcellulose and cellulose ethers such as hydroxypropylcellulose.

A coating liquid is prepared by combining, in a volatile solvent, a resin, a foaming agent and any optional additives. A liquid foam is typically generated from the coating liquid by incorporation of air or other gas such as nitrogen or carbon dioxide. This process may be accomplished by stirring with a high speed stirrer. More advantageously it can be carried out by using a rotor stator mixer which is specifically designed for this task, for example the continuous foaming equipment manufactured by Mondomix BV (Netherlands). This type of equipment enables the ratio of air to liquid to be selected and maintained throughout the foam generation process. The mixer may be located in the supply line to a coating machine, as a so called in-line mixer, to generate the liquid foam for immediate use at a rate commensurate with the coating process.

The application of the liquid foam to the heat-sensitive film can be carried out by standard coating techniques including knife-over-roll, Mayer bar and slot-die methods. The drying process can be carried out by

standard techniques, including hot air drying, which are designed to ensure that the film substrate temperature does not exceed the threshold temperature to incur shrinking.

5 The porous solid foam coating may be formed on one side of the heat-sensitive film or on a sub-coat (eg. an adhesion promoting sub-coat) on the surface of the heat-sensitive film.

10 The solid foam coating that is formed is an open-cell solid foam which permits the flow of liquids, particularly ink, such that when the stencil master has been imaged to create voids in the heat-sensitive film, liquids entering the solid foam coating can exit via the image voids in the film. Lateral connection of the cells in the solid foam is desirable to enable this component of the stencil to act as
15 an ink reservoir and balance the supply of ink between areas where there is a large concentration of image voids and those areas where there are few or none. In order to achieve the desired degree of ink flow through the porous solid foam and to avoid pores becoming blocked by pigmented
20 ink preferably most of the pores are greater than 5 μm in diameter, and more preferably greater than 10 μm in diameter.

Coating weight of the solid foam has some impact on the stiffness of the stencil master, some increase in
25 stiffness being achieved at increased coating weight. However this approach increases material costs and is likely to increase the complexity and cost of the drying process as a result of the need to evaporate greater quantities of the volatile component of the liquid foam.

30 The density of the solid foam, which relates to pore volume, is an important parameter for the control of stiffness and printing properties. The stiffness of the foam increases as the density of the solid foam decreases. Decreasing foam density also increases ink flow. However,
35 there is a potential disadvantage in relying on use of low foam densities to achieve a desired stiffness in that the intrinsic strength of the solid foam eg. resistance to

compression can be adversely affected.

The resulting stencil master may have a thin release coating, eg. silicone resin, on the side opposite to the foam coating, to prevent the film from sticking to the thermal printing head during the imaging process and to prevent fouling of the thermal printing head through the progressive build-up of polymer melt after imaging a number of stencil masters. The release coating may also contain an anti-static agent.

The porous solid foam coating may be the sole porous component of the stencil master or other porous components may be provided on the surface of the solid foam coating opposite to the film side. This additional porous component may be a porous tissue laminated to the solid foam coating. Such tissue may be made by a wet or dry-laid process and comprise natural fibres such as hemp, cellulose, wood-pulp or the like, or alternatively synthetic fibres or microfibres composed of materials such as resin, glass or carbon, or blends of different types of fibre. The additional porous component may also take the form of a further porous coating or printed pattern comprising a thermoplastic or cross-linked resin, anti-static agent or release agent.

Stencil masters according to the present invention may be prepared having a variety of stiffnesses and/or tensile strengths. For instance, stencil masters may be prepared having a stiffness of greater than 25 mN, greater than 35 mN, and even greater than 80 mN, as measured using a Lorentzen and Wettre Stiffness Tester Model SE016 under the following conditions: sample width 38 mm, bending angle 30°, bending length 1 mm, bending speed 5°/s, temperature 22 ± 2°C, relative humidity 65 ± 10%. However, a more meaningful measure of the stiffness of the stencil masters takes into account the coating weight of the solid foam, and preferred stencil masters have a stiffness (mN):coating weight (g/m²) ratio of at least 6, more preferably of at least 8, and most preferably of at least 10.

While the stencil master and stencil of the present invention have been primarily described in relation to their use in digital duplicating printing processes, they also find use in screen printing processes.

5 The present invention is further illustrated by the following Examples.

Examples

Examples 1A-1C

10 Heat-sensitive stencils incorporating solid foam coatings as a porous layer were made by the following method:

Preparation of Liquid Foam

The following components were added to a 500 ml glass beaker:

| | | |
|----|---|--------|
| 15 | i) Water | 33.7 g |
| | ii) 10% solution hydroxypropylcellulose | 8.6g |
| | (Klucel E, Industrial Grade, Hercules Inc) | |
| | in water | |
| | iii) 50% styrene acrylate resin emulsion | 51.4 g |
| 20 | (Revacryl 385, Synthomer Ltd) | |
| | iv) 25% solution ammonium stearate in water | 6.3 g |

25 The combined components were then stirred for 1 minute using a Heidolph Model RGL 500 stirrer using a 50 mm stirrer blade to generate a liquid foam. The foam volume was then measured from its height in the beaker and its viscosity measured by a Brookfield Model DV1+ viscometer at rotation speed 100, using a No.4 spindle.

Preparation of Solid Foam Coatings

30 The liquid foam was coated on to a high shrink polyester film, thickness 2.0 μm , of type used to manufacture conventional heat-sensitive digital stencils, using a wire wound Mayer bar to control the coating thickness. Bars with the following wire diameters were used:

| 35 | <u>Example</u> | <u>Mayer Bar Wire Diameter (inches)</u> |
|----|----------------|---|
| | 1A | 0.070 |

1B 0.075
1C 0.150

The coatings were dried in an oven at a temperature of 60°C for 5 minutes. The resultant solid foam coated film was then measured to determine coating weight, coating thickness, stiffness (using a Lorentzen and Wettre Stiffness Tester Model SE016 under the following conditions: sample width 38 mm, bending angle 30°, bending length 1 mm, bending speed 5°/s, temperature 22 ± 2°C, relative humidity 65 ± 10%) and tensile strength (using a Testometric Micro 350 (fitted with flat face rubber grips) under the following conditions: gauge length 180 mm, gauge width 15 mm, speed 100 mm/min, temperature 22 ± 2°C, relative humidity 65 ± 10%).

A thin silicone coating was applied to the film surface opposite the solid foam and dried. The resultant stencil masters were then imaged and printed on a Gestetner CopyPrinter Model 5380 digital duplicator. The stencils all gave good image density (measured using a Macbeth RD914 densitometer) and even ink coverage.

The results for Examples 1A - C are summarised in Table 1, below.

Examples 2A-2G

25 Preparation of Liquid Foam

The method described for Example 1 was used except that for examples 2A - 2G alternative resin emulsions were used as below:

| 30 | <u>Example</u> | <u>Resin Emulsion</u> | <u>Amount</u> |
|----|----------------|---|---------------|
| | 2A | 35% fully reacted polyurethane (Ucecoat DW7770, UCB Ltd) | 81.9 g |
| | 2B | 40% acrylate/methacrylate copolymer (NeoCryl BT-20, NeoResins) | 64.2 g |
| 35 | 2C, F, G | 50% styrene/acrylate copolymer (Revacryl 385, Synthomer Ltd) | 51.2 g |

| | | |
|----|--|--------|
| 2D | 50% styrene/acrylate copolymer (Revacryl 385, Synthomer Ltd) | 57.4 g |
| 2E | 42% styrene/acrylonitrile copolymer (Revacryl 826, Synthomer Ltd) | 68.3 g |

5

For all the above examples the amount of water was adjusted to give a total combined weight of 85.1 g.

The weights of hydroxypropyl cellulose and ammonium stearate solutions were the same as Example 1.

10 Preparation of Solid Foam Coatings

The method described for Example 1 was used with Mayer bar wire diameters as indicated below. The gap-wound bars used in this and later examples were manufactured by RK Print Coat Instruments Ltd (UK).

15

| <u>Example</u> | <u>Mayer Bar Wire Diameter (inches)</u> |
|----------------|---|
| 2A | 0.050 |
| 2B, 2C | 0.064 |
| 20 2D, 2E, 2F | 0.075 |
| 2G | 0.150 (gap wound) |

The Mayer bar wire diameter was selected so that approximately the same weight of coating was achieved for each example (12.55-12.99 g/m²). The results, summarised in Table 2 below, indicate that for an equivalent coating weight stiffness relates to coating density regardless of polymer type.

25 Example 3

30 The liquid foam was the same as that used in Example 1. The solid foam was prepared by exactly the same process as in Example 1 using gap-wound Mayer bars with wire diameters as indicated below:

35

| <u>Example</u> | <u>Mayer Bar Wire Diameter (inches)</u> |
|----------------|---|
|----------------|---|

| | |
|----|-------|
| 3A | 0.150 |
| 3B | 0.200 |
| 3C | 0.300 |

5 The results obtained are summarised in Table 3, below.
The stiffness of the coatings increases with coating weight.

Example 4

10 This example is analogous to Example 3 with the incorporation of carbon fibre.

Preparation of Liquid Foam

The following components were combined to foam the liquid phase.

| | | |
|----|--|--------|
| 15 | i) Water | 31.1 g |
| | ii) 10% solution hydroxypropylcellulose (Klucel E, Industrial Grade, Hercules Inc) | 8.6 g |
| | iii) 50% styrene acrylate resin emulsion (Revacryl 385, Synthomer Ltd) | 51.4 g |
| 20 | iv) Carbon fibre (3 mm length, diameter 7 microns) | 2.6 g |
| | v) 25% ammonium stearate solution | 6.3 g |

25 The liquid foam was prepared in the same manner as Example 3 to achieve an identical foam volume.

Preparation of Solid Foam Coatings

Solid foams were prepared by the same method as Example 3 using gap-wound Mayer bars with wire diameters indicated below:

| | | |
|----|----------------|---|
| 30 | <u>Example</u> | <u>Mayer Bar Wire Diameter (inches)</u> |
| | 4A | 0.150 |
| | 4B | 0.300 |
| 35 | 4C | 0.400 |

The results for Example 4 are summarised in Table 3,

below. The effect of adding carbon fibre is to achieve significant increases in both stiffness and tensile strength compared with equivalent coatings where the carbon fibre is absent. Tensile strength increased with increasing coating weight when carbon fibre is incorporated, unlike the comparative coatings.

Example 5

The liquid foam was the same as that used in Example 1. The solid foam was prepared by exactly the same process as in Example 1 using a Mayer bar with a wire diameter of 0.200 inches.

The results for this example are summarised in Table 4, below.

Examples 6A and 6B

Preparation of Liquid Foam

The following components were added to a 500 ml glass beaker:

| | |
|---|--------|
| Water | 1.0 g |
| 10% solution hydroxypropylcellulose (Klucel E, Industrial Grade, Hercules Ltd) | 8.6 g |
| 35% radiation curable polyurethane emulsion (Ucecoat DW 7849, UCB Ltd) | 77.8 g |
| 25% ammonium stearate solution in water | 12.6 g |

The liquid foam was prepared as Example 1 except that the components were stirred for a period of two minutes.

Preparation of Solid Foam Coating

Solid foam coatings were prepared by the method of Example 1 using a Mayer bar with a wire diameter of 0.075 inches. After drying, Example 6B was irradiated by an electron beam source providing a dose of 4 MRad at 200 volts acceleration voltage.

The results for these examples are summarised in Table 4, below. Example 6A is of comparable coating weight to Example 5 but has higher density and significantly lower stiffness. Sample 6B which was subjected to EB irradiation

demonstrates a significant increase in both stiffness and tensile strength in comparison with both Example 5 and Example 6A.

TABLE 1

| PARAMETERS | DETAILS | MEASURES |
|--------------------------------|--|-------------------|
| Liquid Phase component | | Example 1 |
| Water | | parts by weight |
| 10% Klucel 99-E solution | Hydroxypropylcellulose | 33.7 |
| Revacryl 385 | | 8.6 |
| 25% ammonium stearate solution | Styrene/acrylate emulsion (50% solids) | 51.4 |
| | | 6.3 |
| TOTAL | | 100 |
| Coating Foam | | |
| Air:liquid ratio | Foam volume/liquid volume | 3.8 |
| Viscosity (cP) | Brookfield spindle 4, speed 100 | 2000 |
| Solid Foam coating | | |
| Mayer bar wire | Wire diameter (inches) x 1000 | 1A 1B 1C |
| Coating Weight | g/m ² | 70 75 150 |
| Thickness | microns | 7.25 8.25 10.85 |
| Density | g/cm ³ | 55.4 65.8 91.0 |
| Stiffness | mN | 0.131 0.125 0.119 |
| Tensile strength | kgf | 16 33 45 |
| | | 0.29 0.31 0.31 |
| Printing Quality | | |
| Image density | Macbeth RD 914 densitometer | 1.00 0.99 1.02 |

TABLE 2

| PARAMETERS | DETAILS | MEASURES | | | | | | | |
|--------------------------------|---|----------|-------|-------|-------|-------|-------|-------|--|
| | | Examples | | | | | | | |
| | | 2A | 2B | 2C | 2D | 2E | 2F | 2G | |
| Liquid Phase component | | | | | | | | | |
| Water | | 3.2 | 13.4 | 33.7 | 27.7 | 16.8 | 33.7 | 33.7 | |
| 10% Klucel 99-E solution | Hydroxypropylcellulose | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | |
| Ucecoat DW7770 | Fully reacted polyurethane (35% solids) | 81.9 | - | - | - | - | - | - | |
| Neocryl BT-20 | Acrylate copolymer (40% solids) | - | 71.7 | - | - | - | - | - | |
| Revacryl 385 | Styrene acrylate (50% solids) | - | - | 51.4 | - | - | - | - | |
| Revacryl 385 | Styrene acrylate (50% solids) | - | - | - | 57.4 | - | - | - | |
| Revacryl 826 | Acrylate/acrylonitrile (42% solids) | - | - | - | 68.3 | - | - | - | |
| Revacryl 385 | Styrene acrylate (50% solids) | - | - | - | - | - | 51.4 | - | |
| Revacryl 385 | Styrene acrylate (50% solids) | - | - | - | - | - | - | 51.4 | |
| 25% ammonium stearate solution | | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | |
| TOTAL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | |
| Coating Foam | | | | | | | | | |
| Air:liquid ratio | Foam volume/liquid volume | 2.0 | 2.5 | 2.0 | 3.3 | 3.0 | 2.0 | 3.5 | |
| Viscosity (cP) | Brookfield spindle 4, speed 100 | 1240 | 2076 | - | 1242 | 1950 | - | 1536 | |
| Solid Foam coating | | | | | | | | | |
| Mayer bar wire | Wire diameter (inches) x 1000: | 50 | 64 | 64 | 75 | 75 | 75 | 150 | |
| Coating Weight | g/m ² | 12.57 | 12.97 | 12.70 | 12.99 | 12.55 | 12.55 | 12.67 | |
| Thickness | microns | 30.8 | 51 | 51.0 | 52.4 | 60.6 | 70.4 | 110.4 | |
| Density | g/cm ³ | 0.408 | 0.254 | 0.249 | 0.248 | 0.207 | 0.178 | 0.115 | |
| Stiffness | mN | 13 | 26 | 28 | 27 | 32 | 38 | 46 | |
| Tensile strength | kgf | 0.35 | 0.36 | 0.35 | 0.34 | 0.37 | 0.33 | 0.32 | |

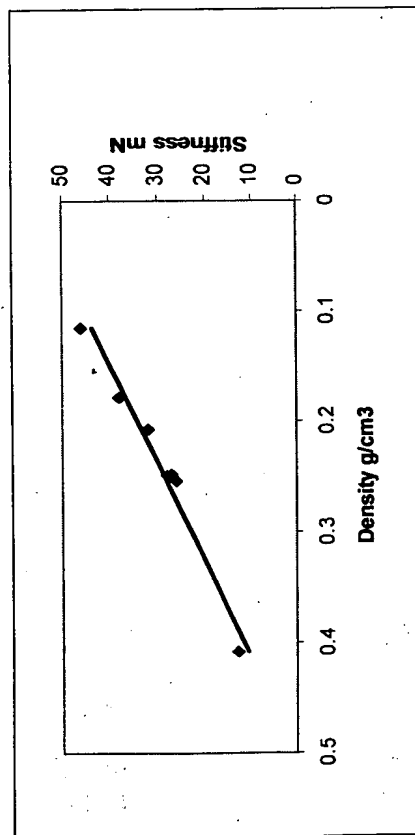


TABLE 3

| PARAMETERS | DETAILS | MEASURES |
|--------------------------------|--|---|
| | | Examples |
| Liquid Phase component | | |
| Water | | 3 parts by weight |
| 10% Klucel 99-E solution | | 33.7 |
| Revacryl 385 | Hydroxypropylcellulose | 8.6 |
| Carbon fibre | Styrene/acrylate emulsion (50% solids) | 51.4 |
| 25% ammonium stearate solution | | 2.6 |
| TOTAL | | 100 |
| Coating Foam | | |
| Air:liquid ratio | Foam volume/liquid volume | 3.5 |
| Viscosity (cP) | Brookfield spindle 4, speed 100 | 1536 |
| Solid Foam coating | | |
| Mayer bar wire | Wire diameter (inches) x 1000 | 3A 150 3B 200 3C 300 4A 150 4B 300 4C 400 |
| Coating Weight | g/m ² | 12.67 17.82 23.43 12.73 19.49 23.97 |
| Thickness | microns | 110.4 159.8 175.4 101.6 148.8 206.8 |
| Density | g/cm ³ | 0.115 0.112 0.134 0.125 0.131 0.116 |
| Stiffness | mN | 46 109 165 105 278 415 |
| Tensile strength | kgf | 0.3264 0.3544 0.3527 0.4363 0.7556 0.8912 |

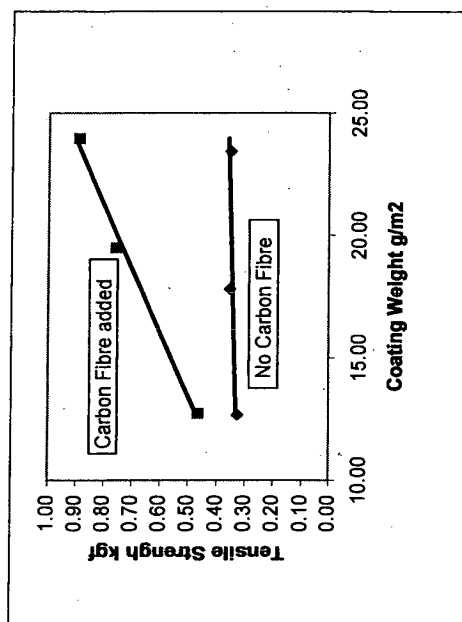
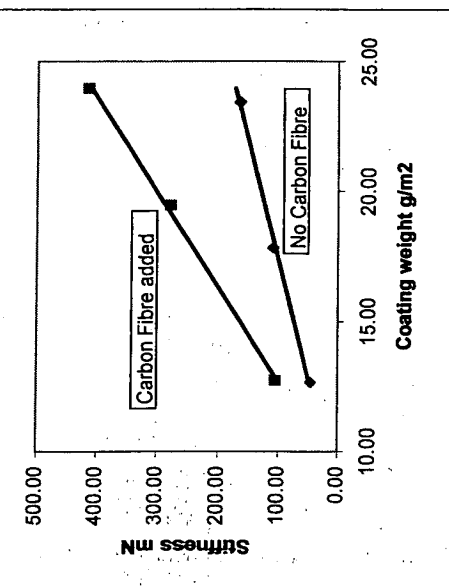


TABLE 4

| PARAMETERS | DETAILS | MEASURES |
|--------------------------------|---------------------------------|---|
| Liquid Phase component | | Examples 5 6 parts by weight |
| Water | | 33.7 1.0 |
| 10% Klucel 99-E solution | Hydroxypropylcellulose | 8.6 8.6 |
| Revacryl 385 | Styrene/acrylate | 51.4 - |
| Ucecoat DW 7849 | Radiation-curable polyurethane | - 77.8 |
| 25% ammonium stearate solution | | 6.3 12.6 |
| TOTAL | | 100 100.0 |
| Coating Foam | | |
| Air:liquid ratio | Foam volume/liquid volume | 3.8 2.2 |
| Viscosity (cP) | Brookfield spindle 4, speed 100 | 2022 2280 |
| EB Curing | | |
| Dose | Mrad | - - 4 |
| Acceleration voltage | Volts | - - 200 |
| Solid Foam coating | | |
| | | 5 6A 6B |
| Mayer bar wire | Wire diameter (inches) x 1000 | 200 75 75 |
| Coating Weight | g/m2 | 14.67 15.15 15.07 |
| Thickness | microns | 125.0 41.4 42.6 |
| Density | g/cm3 | 0.117 0.366 0.354 |
| Stiffness | mN | 75 15 120 |
| Tensile strength | kgf | 0.33 0.33 0.72 |

CLAIMS

1. A heat-sensitive stencil master comprising a heat-sensitive polymeric film having a thickness of less than 10 μm and, coated thereon, a solid resinous foam comprising a foaming agent.
2. A stencil master according to claim 1, wherein the foaming agent is a surfactant having an HLB of greater than 6.
3. A stencil master according to claim 1 or claim 2, wherein the solid foam incorporates a fibrous material.
4. A stencil master according to claim 3, wherein the fibrous material has a diameter of greater than 1 μm and less than 10 μm , and a length in the range 1 to 14 mm.
5. A stencil master according to claim 3 or claim 4, wherein the fibrous material is selected from carbon fibres, glass fibres, and polymeric fibres such as polyester fibres and polyvinyl alcohol fibres.
6. A stencil master according to claim 5, wherein the fibrous material comprises carbon fibre.
7. A stencil master according to claim 7, wherein the solid foam comprises a thermoplastic resin.
8. A stencil master according to any of claims 1 to 6, wherein the solid foam comprises a cross-linked resin.
9. A stencil master according to claim 8, wherein the resin is cross-linked by irradiation.
10. A stencil master according to claim 9, wherein the resin is cross-linked by electron beam irradiation.
11. A stencil master according to claim 8, wherein the resin is a polyurethane cross-linked through unsaturated acrylate groups.
12. A stencil master according to any preceding claim, wherein the solid foam incorporates an antistatic agent.
13. A stencil master according to any preceding claim, wherein the heat-sensitive polymeric film has a release coating on the side of the film opposite the solid

foam.

14. A method for manufacturing a heat-sensitive stencil comprising coating on to a heat-sensitive polymeric film having a thickness of less than 10 μm , a liquid foam
5 comprising a resin dispersed or dissolved in a volatile liquid, and, optionally, a foaming agent, and drying the liquid foam to form a solid foam coating.

15. A method according to claim 14, wherein the volatile liquid is water.

10 16. A stencil master obtainable by a method as defined in claim 14 or claim 15.

17. A stencil for use in a digital duplicating printing process comprising a stencil master as defined in any of claims 1 to 13 and 16, which has been thermally
15 imaged to produce voids in the heat-sensitive polymeric film.

18. Use in a digital duplicating printing process, of a stencil master as defined in any of claims 1 to 13 and 16.

20 19. Use in a digital duplicating process, of a stencil as defined in claim 17.

